

A NEW MELIOLOID FUNGUS FROM THE EARLY EOCENE OF TEXAS

by C. P. DAGHLIAN

ABSTRACT. A new species of *Meliolinites* Selkirk, *M. dilcherii*, is reported from the Early Eocene of Texas, U.S.A. The specimens show various stages of perithecial development which are the same as those reported in extant meliolas. This is the oldest known occurrence of the genus.

FUNGI of the family Meliolaceae, usually parasitic on adult leaves, are commonly known as dark mildews. They are found in warm, humid, forested, tropical areas, but may also occur in seasonally dry regions (Yarwood 1973). Fossil melioloid epiphyllous fungi have been reported from the Eocene of Germany (Köch 1939), the Eocene of Tennessee (Dilcher 1965), and the Miocene of Australia (Selkirk 1975). In all cases the fungi were found on angiosperm leaves. Köch (1930) described some material of *Meliola* from the Eocene brown coals of Germany, but little information can be obtained from it because of the incomplete description. Dilcher (1965) was able to distinguish two species of *Meliola*, which have all phases of growth except the perithecial stage. *M. anfracta* Dilcher has the characteristic mycelial setae found in extant meliolas, while *M. spinksii* Dilcher lacks setae, but has other melioloid characters. Selkirk (1975) recognized the fossil genus *Meliolinites* for those forms of epiphyllous fungi which lack setae but otherwise conform to the characters of the Meliolaceae. Selkirk reported one species from New South Wales, *M. nivalis*, with typical spores, mycelia, and hyphopodia. He figured one poorly preserved perithecium of *M. nivalis*, but was unable to observe any taxonomically useful characters. Specimens studied in this report have typical melioloid spores, mycelia, and hyphopodia, as do the species mentioned above. In addition, there are several stages of perithecial development present. This is also the oldest reported occurrence of *Meliolinites* in the fossil record.

Specimens were collected from clay pits of the Elgin-Standard Brick Manufacturing Company, Butler, Texas, located about 50 km east of Austin, Texas in northern Bastrop County. Clay is stripped from the Butler Clay, a basal bed of the Calvert Bluff member of the Lower Eocene Rockdale Formation (Fisher 1961). The Rockdale Formation of the Texas Gulf coast is primarily deltaic sediment and forms over 80% of the Wilcox Group in Texas (Fisher and McGowen 1967). The Calvert Bluff Member contains most of the commercial lignite in central Texas and represents upper delta plain sediments with lignites, deposited in interdistributary regions (Fisher and McGowen 1967; Kaiser 1974). Atlee and others (1968) have suggested interdistributary backswamp or open-lake deposition for the Butler Clay. There are about 5 m of alternating sand, sandy to silty clay, and clay exposed at the pits.

Fungus-bearing leaf fragments were collected from a thin lens of dark grey, fine-grained clay below a layer of ironstone concretions (Irving and Stuessy 1974). Blocks

of clay were soaked in distilled water to remove the leaf fragments, cleaned in hydrofluoric acid, washed several times, and mounted for light microscopy. Macerations were not needed because the leaves were very light coloured and consisted almost entirely of cuticle with little or no mesophyll tissue.

SYSTEMATIC DESCRIPTION

Family MELIOLACEAE Martin ex Hansford, 1946

Genus MELIOLINITES Selkirk, 1975

Meliolinites dilcherii sp. nov.

Plate 13, figs. 1-6; text-fig. 1

Holotype. The University of Texas Paleobotanical Collection No. 207 (text-fig. 1).

Paratypes. UTPC No. 204 (Pl. 13, fig. 1), UTPC No. 205 (Pl. 13, figs. 2-4), UTPC No. 206 (Pl. 13, figs. 5, 6).

Locality. Butler Clay Member, Rockdale Formation, Wilcox Group. Lower Eocene, Butler, Bastrop County, Texas.

Diagnosis. Species with hyphal branches and capitate hyphopodia alternate to unilateral, rarely opposite; tapered five-celled spores with bipolar germination; lacking mycelial setae and mucronate hypopodia. Mature perithecia at least 155.0 μm in diameter with radiating basal cells, no perithecial appendages.

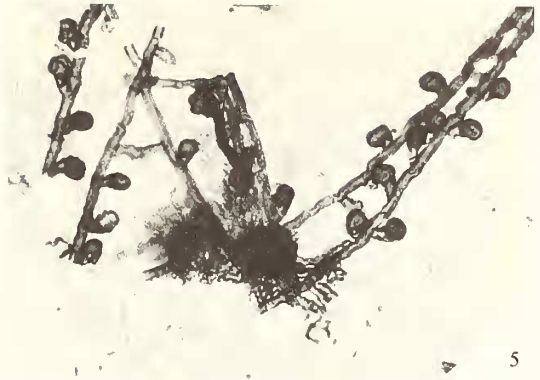
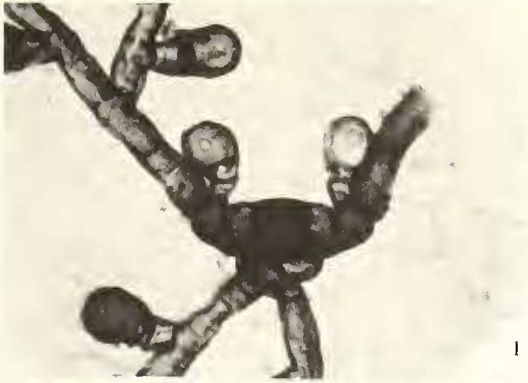
Beeli formula (modified after Hansford, 1961): 3,(1),-, 1.4,2,2,-.

Description. Epiphyllous fungi, colonies 1.5-2.0 mm in diameter, thin to subdense. Hyphal branching alternate to unilateral (rarely opposite) at acute angles (45-60°). Hyphal cells 6.6 μm wide, 24.6 μm long, thick walled, straight to slightly sinuous. Capitate hyphopodia 22.0-26.4 μm long, unilateral to alternate, rarely opposite, usually spreading from hyphae at 40-60°, but may be more obtuse. Stalk cells 6.6-11.0 μm long, uniformly 8.8 μm wide, may taper towards the head cells. Head cells 15.4 μm long, 15.4-17.6 μm wide, often with slightly undulate walls. Walls thick, haustorial pore evident in most head cells. No mucronate hyphopodia nor mycelial setae observed. Developing perithecia small globose bodies, 44.0 \times 37.5 μm , on base of radiating cells. Mature perithecia 155.0 μm in diameter. No perithecial setae observed. Spores 44.0 \times 15.4 μm , four-septate, five-celled, middle cell largest, end cells tapered. Bipolar germination with primary hyphopodia produced from each end cell. Hyphae developed from all cells except the middle one. Occurs on upper epidermis of apparently lauraceous leaves.

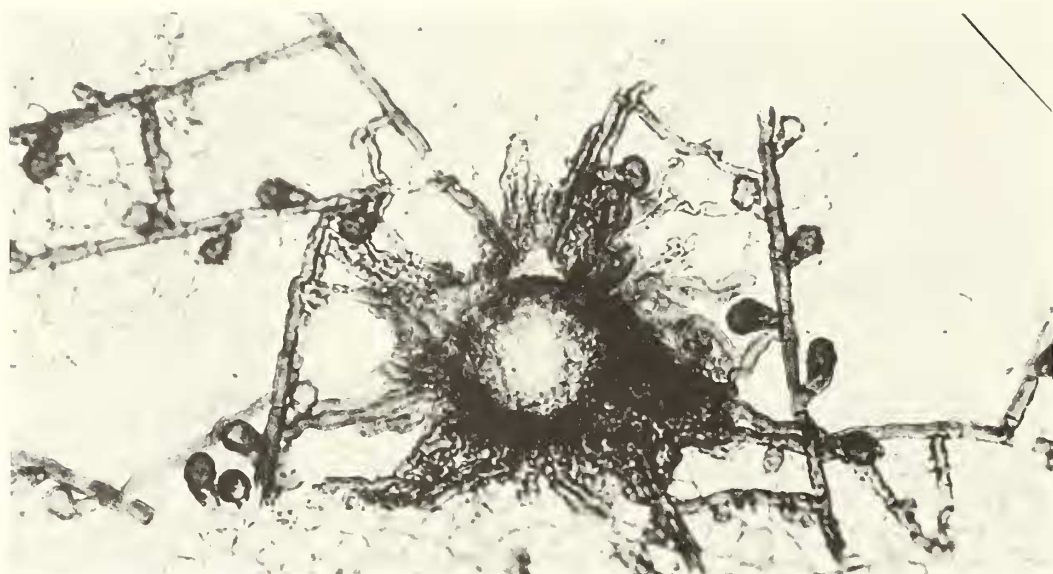
Remarks. Spores of *Meliolinites dilcherii* are four-septate, five-celled, and taper towards each end (Pl. 13, fig. 1), a common configuration for the Meliolaceae. Germination is bipolar with each end cell producing a primary hyphopodium.

EXPLANATION OF PLATE 13

Figs. 1-6, *Meliolinites dilcherii* sp. nov. 1, \times 500, germinated spore with primary hyphopodia and vegetative mycelium. Note haustorial pores in capitate head cells. 2, \times 200, vegetative mycelium showing branching. 3, \times 200, 4, \times 800, small mass of cells from early stage of perithecial development. 5, \times 200, 6, \times 800, globose body of cells with radiating hyphae.



DAGHLIAN, Melioid fungus



TEXT-FIG. 1. Partially crushed mature perithecium with radiating hyphae, $\times 300$.

Primary hyphopodia develop in extant meliolas, with subsequent development arrested unless the spore has landed on an appropriate host (Hansford 1961). This is important, since there seems to be a high degree of host specificity in extant meliolas. Both Dilcher (1965) and Selkirk (1975) found similar specificity in the fossils they studied. Although several extant meliolas have bipolar germination, none of them has spore shapes like *M. dilcherii*. Hyphae are produced from all cells of the spore except the middle one, even from the cells that produced the primary hyphopodia (Pl. 13, fig. 1). Hyphae branch at their distal ends at angles of $45-60^\circ$, producing a relatively thin colony, although in some places the hyphae are crowded (Pl. 13, fig. 2). Hyphopodia, each composed of two cells, a short stalk cell and capitate head cell, branch from the hyphae at $40-45^\circ$. The hyphopodia are short, modified branches which provide the only connection of the fungus to the host cells. From the centre of each head cell there is a haustorial pore through which the haustorium enters the host cell. No haustoria were found, probably due to their delicate nature.

Several stages in the development of perithecia are present in the material studied. There is, to the author's knowledge, only a single reference to perithecial development in meliolas, that of Graff (1932). A small lateral branch, at first indistinguishable from a capitate hyphopodium, enlarges and divides to produce a small mass of cells. These enlarge and divide further to form the perithecium (Hansford 1961). Cytological details are not clear. The initial mass of cells may produce a radiating layer of cells with or without capitate hyphopodia. The fossil species has several structures which appear to correspond to some of these developmental stages.

The earliest stage represented in the fossil material is one in which the small mass of cells has formed from the perithecial initial. Plate 13, figs. 3, 4 show this as a small cluster of cells near vegetative hyphae. While hyperparasites do occur on meliolas,

the similarity between these cells and those of a later stage (Pl. 13, figs. 5, 6) suggests that this is indeed a part of the developing perithecium. The small mass of cells later produces a series of radiating hyphae from beneath a globose body of cells (Pl. 13, figs. 5, 6). At higher magnifications it is clear that these cells are continuous with the vegetative hyphae (Pl. 13, fig. 6). Apparently the basal disc of radiating cells continues to enlarge to more than twice the diameter of the perithecium (Pl. 13; text-fig. 1). There is no evidence of hyphopodia on these radiating hyphae. The largest perithecium, presumably mature, although no spores were found within it, shows the lower portion of the perithecium and the numerous radiating hyphae (text-fig. 1). There are no setae or appendages of any kind on the lower portion of the perithecium. Unless they were present on the upper two-thirds of the perithecium, this species lacked any kind of mycelial or perithecial setae, an unusual feature in the Meliolaceae. Only the genus *Asteridiella* is without setae in the Meliolaceae (Hansford 1961). However, without complete perithecia it is not possible to place this fossil in an extant genus because some species of Meliolaceae have setae only on the perithecia (Hansford 1961). The fossil is best placed in the genus *Meliolinites* Selkirk. The stages of perithecial development in the fossil species are, so far as can be determined, the same as those in extant meliolas. Further collection and study should reveal additional stages of development as well as mature, whole perithecia.

The host leaves are fragmentary and oxidized, and are similar to leaves described by Ball (1931) and reported by Irving and Stuessy (1965) as *Nectandra*. In view of the estimate that up to 60% of the generic identifications made by early workers in the Eocene of south-eastern North America are incorrect (Dilcher 1973), the lauraceous affinities of the host leaves must be regarded as tentative at best. A detailed comparative study of the morphology and anatomy of the host leaves and modern lauraceous leaves will be required to provide a reliable identification. Hansford (1961) recognized forty-three species of meliolid fungi which parasitize lauraceous plants. None of these are similar to *M. dilcherii*.

Acknowledgements. This work was supported in part by a Grant-in-aid from Sigma Xi to the author and by NSF Grant DEB 73-01428 to T. Delevoryas. Thanks are extended to T. Delevoryas for assistance in the preparation of the manuscript and for helpful suggestions during the course of the research and to G. T. Cole and C. J. Alexopoulos for their aid. This work was carried out in the Botany Department of the University of Texas at Austin, and I am grateful for the facilities provided during my period as a graduate student there.

REFERENCES

- ATLEE, W. A., ELSIK, W. C., FRAZIER, D. E. and ZINGULA, R. P. 1968. Environments of deposition. Wilcox Group. *Houston Geol. Soc. field trip guidebook*, pp. 1-43.
- BALL, O. M. 1931. A contribution to the paleobotany of the Eocene of Texas. *Bull. agric. mech. Coll. Texas*, 4th ser., **2**, 1-173, pls. 1-48.
- DILCHER, D. L. 1965. Epiphyllous fungi from Eocene deposits in western Tennessee, U.S.A. *Palaeontographica*, **116 B**, 1-49, pls. 1-26.
- 1973. A revision of the Eocene flora of southeastern North America. *Palaeobotanist*, **20**, 7-18.
- FISHER, W. L. 1961. Stratigraphic names in the Midway and Wilcox Groups of the Gulf Coastal Plain. *Trans. Gulf Coast Ass. geol. Soc.* **11**, 263-295.
- and MCGOWEN, J. H. 1967. Depositional systems in the Wilcox Group of Texas and their relationship to occurrence of oil and gas. *Ibid.* **17**, 105-125.

- GRAFF, P. W. 1932. The morphological and cytological development of *Meliosira circinans*. *Bull. Torrey Bot. Club*, **59**, 241-266.
- HANSFORD, C. G. 1961. The Meliolineae: a monograph. *Sydowia Ann. Micologici*, Ser. II, Supp. 2, 1-806.
- IRVING, R. S. and STUESSY, T. F. 1971. A new paratropical angiosperm florule in the Eocene Rockdale Formation of Bastrop County, Texas. *Southwest. Nat.* **16**, 111-116.
- KAISER, W. R. 1974. Texas lignite: near-surface and deep-basin resources. *Bur. econ. Geol. Univ. Texas, Rept. Invest.* **79**, 1-70.
- KÖCH, C. 1939. Fossile Kryptogam aus der eozänen Braunkohle des Geiseltales. *Nova Acta Acad. Leop. Carol.* N.S. **6**, 333-359.
- SELKIRK, D. R. 1975. Tertiary fossil fungi from Kiandra, New South Wales. *Proc. Linn. Soc. N.S.W.* **100**, 70-94, pls. 2-12.
- YARWOOD, C. E. 1973. Pyrenomycetes. In AINSWORTH, G. C., SPARROW, K. and SUSSMAN, A. S. (eds.). *The Fungi; an advanced treatise*. IV-A a taxonomic review with keys: Ascomycetes and Fungi Imperfecti. Academic Press, N.Y., 71-86.

Typescript received 19 October 1976

Revised typescript received 24 January 1977

CHARLES P. DAGHLIAN
Department of Botany
Ohio State University
1735 Neil Avenue
Columbus, Ohio 13210, U.S.A.